DOI:
10.1177/0269215517704270

Document Version
Peer reviewed version

CLINICAL REHABILITATION

TITLE PAGE

Extended Title: Changes in physical activity following total hip or knee arthroplasty: a matched case-control study from the EPIC-Norfolk cohort.

Running Headline: Physical activity post-arthroplasty: analysis of EPIC-Norfolk

Authors: Smith TO, Withers TM, Luben R, Sackley C, Jones AP, MacGregor AJ,

Research Team

Dr Toby Smith – Lecturer in Physiotherapy – School of Health Sciences, Faculty of Medicine and Health Sciences, University of East Anglia, Norwich – email: toby.smith@uea.ac.uk

Mr Tom Withers – PhD Candidate – School of Health Sciences, Faculty of Medicine and Health Sciences, University of East Anglia, Norwich – email: t.withers@uea.ac.uk

Dr Robert Luben - Head of Bioinformatics - EPIC Strangeways Research Laboratory, University of Cambridge, Cambridge, UK – email: robert.luben@phpc.cam.ac.uk

Professor Cath Sackley – Professor of Rehabilitation, Faculty of Life Sciences & Medicine, King's College London, UK – email: catherine.sackley@kcl.ac.uk

Professor Andy Jones – Professor in Public Health – Norwich Medical School, University of East Anglia, Norwich – email: a.p.jones@uea.ac.uk

Professor Alex Macgregor – Professor of Genetic Epidemiology, Norwich Medical School, University of East Anglia, Norwich – email: a.macgregor@uea.ac.uk

Corresponding Author: Dr TO Smith, Queen's Building, Faculty of Medicine and Health Sciences, University of East Anglia, Norwich Research Park, Norwich, NR4 7TJ, United Kingdom. Email: toby.smith@uea.ac.uk; Telephone: 044 (0)1603 593087; Fax: 044 (0)1603 593166

ACKNOWLEDGEMENTS: None

AUTHOR CONTRIBUTIONS

(1) the conception and design of the study, or acquisition of data, or analysis and interpretation of data: TS, AM, RL, CS, AJ

(2) drafting the article or revising it critically for important intellectual content: TS, AM, RL, CS, AJ

(3) final approval of the version to be submitted: TS, AM, RL, CS, AJ

ROLE OF THE FUNDING SOURCE

No funding was obtained for the conduct of this analysis.

CONFLICT OF INTEREST

None of the authors declare a competing interest in relation to this paper.

ABSTRACT

Objective: To assess self-reported physical activity changes pre- compared to post-operatively in patients undergoing total hip or knee arthroplasty, and to compare this to an age- and gender-matched cohort of people who have not undergone arthroplasty.

Design: Population-based prospective cohort study.

Setting: Norfolk, UK

Subjects: People who had undergone hip or knee arthroplasty, compared to an age- and gender-matched non-arthroplasty cohort.

Intervention: Primary total hip or knee arthroplasty.

Main measures: Physical activity, measured using the EPIC Physical Activity Questionnaire (EPAQ2).

Results: 400 people from the EPIC-Norfolk community cohort were identified who had undergone hip or knee arthroplasty. 767 people were identified to form an age- and gender-matched non-arthroplasty cohort. Mean post-operative follow-up was 43 months post-total hip and 41 months post-total knee arthroplasty. There was a statistically significant reduction from pre- to post-arthroplasty in the number of flights of stairs climbed weekly (hip: mean difference (MD): 6.8; $p<0.01$; knee: MD: 10.2; $p<0.01$); duration of walking (hip: MD: 1.4 hours/week; $p=0.02$; knee: MD: 2.2 hours/week; $p<0.01$) and duration of total recreational activity (hip: MD: 1.1 hours/week; $p=0.02$). Compared to the non-arthroplasty cohort, duration of physical activity was lower post-total hip arthroplasty (MD: 1.8 hours/week; $p=0.01$). The number of flights of stairs climbed weekly (MD: 12.0; $p<0.01$), total recreational activity (MD: 1.7 hours/week; $p=0.04$) and physical activity energy expenditure

(MD: 5.7 Mets-hours/week; p=0.05) was lower for people post-total knee arthroplasty compared to the matched controls.

Conclusions: Physical activity did not increase, and in instances decreased, following total hip or knee arthroplasty.

Keywords: Joint replacement; osteoarthritis; physical activity; rehabilitation; exercise

INTRODUCTION

Total hip and knee arthroplasty are two of the most common orthopaedic operations performed worldwide [1]. By 2030, it has been estimated that the demand for primary total hip arthroplasty is expected to increase by 174% globally. [3] We recently reported a systematic review investigating physical activity post- hip arthroplasty. [7] This identified 17 previous trials assessing physical activity following total hip arthroplasty. [8-24] The review indicated no clear evidence of a change in physical activity following total hip arthroplasty. Similarly in total knee arthroplasty, Kahn and Schwarzkopf [25] reported that there was no significant difference in activity levels, as measured using accelerometery, before compared to after total knee arthroplasty. These were surprising conclusions since it is a commonly held view by clinicians and the public that following arthroplasty, physical activity should increase through reduced joint restriction, pain and overall disability [7].

Whilst both Withers et al [7] and Kahn and Schwarzkopf [25] have reported limited change in physical activity, it remains unclear whether the level of physical activity engagement is dependent on the type of activity pursued post-arthroplasty, or how this relates to the normative non-joint pathology population. This is important as determining the normative return to physical activity following total hip or knee arthroplasty not only has health implication to the individual, [5,6] but also has socioeconomic implications on return to work and direct social care costs associated with recovery and continuing support following arthroplasty.

This study aimed to address these limitations through a UK-based cohort, the European Prospective Investigation of Cancer (EPIC)-Norfolk. The EPIC-Norfolk cohort provides a valuable resource to answer this research question since it captures data at a population-level

in the years before surgery, not simply in the immediate pre-operative period when a patient might be expected to be debilitated by their symptoms. The EPIC-Norfolk cohort also allows an analysis of various different types of physical activity, over a follow-up period longer than 12 to 24 months, which has been lacking in the evidence to-date. Using this, we therefore aimed to determine: (1) whether there is a change in physical activity following total hip or knee arthroplasty by the type of physical activity pursuit; and (2) whether there is a difference in physical activity between people following total hip or knee arthroplasty compared to an age- and gender-matched non-arthroplasty cohort.

METHODS

This is a population-based observational study which aimed to assess self-reported physical activity changes pre- compared to post-operatively in people who had undergone total hip or knee arthroplasty.

The Cohort

The study participants were people who had undergone a total hip or knee arthroplasty between Health Check 2 (1998-2001) and a minimum six months prior to Health Check 3 (2006-2011) in the EPIC-Norfolk cohort. The detailed study protocol for EPIC-Norfolk has been previously described. [26] In summary, men and women aged 40 to 75 years from 35 participating general practices in Norfolk (United Kingdom) were invited to participate. A total of 25,639 participants attended a baseline health examination in 1993 to 1997. All provided written consent to participate in the study as approved by the National Health Service, Norfolk Research Ethics Committee.

For this analysis, participants were included if they had undergone primary unilateral total hip or knee arthroplasty. The identification of total hip or knee arthroplasty was initially self-reported. Number of joint replacements, type of joint and date of procedure was then verified using the Hospital Episode Statistics data with ICD10 codes W37-W39 (hip) and W40-W42 (knee). We excluded the following: revision or bilateral joint replacement surgery, joint replacement surgery as a result of trauma, cancer or rheumatoid arthritis, or those who had a joint arthroplasty less than six months prior to Health Check 3 since people's recovery following total hip or knee arthroplasty has been reported to plateau by six months post-surgery. [27,28]

To assess the second research question, we identified an age- and gender-matched cohort of people who had not undergone lower limb joint arthroplasty. All participants who did not have a total hip or knee arthroplasty before or during the follow-up assessments were eligible. Two controls were matched per case. Controls were matched to cases on: sex, date of birth (± 3 years) and the day of baseline health check (± 3 months). This formed our normative, matched cohort for the arthroplasty versus non-arthroplasty analyses.

Data Collection

Data were collected at a health examination by a trained nurse. At each assessment, health and lifestyle questionnaires were used to self-record information on physical activity, prevalent illness and personal characteristics including: age, gender, body mass index, previous diagnoses of myocardial infarct, stroke, asthma, diabetes and arthritis, and physical activity. Physical activity was assessed through a validated, self-reported physical activity instrument (EPAQ2) [29], which assessed the: frequency of flights of stairs climbed (per week), duration of walking to work or for pleasure (hours per week), duration of total

recreational activity (hours per week), physical activity energy expenditure at home (Met-hours per week). [29]

Data Analysis

We performed a stratified analysis to examine changes in physical activity pre-arthroplasty and post-arthroplasty following unilateral total hip or knee arthroplasty between the health check intervals. Data were analysed separately for total hip and knee arthroplasty given the documented difference in functional outcomes between these procedures. [30,31] Data distribution was assessed using the Shapiro-Wilk W test.

All data were analysed through descriptive statistics (frequency/mean/mean difference (MD)/standard deviation (SD)). Absolute mean difference was determined in pre- to post-arthroplasty: frequency of flights of stairs climbed per week, duration of walking to work or for pleasure (hours per week), duration of total recreational activity (hours per week), and physical activity energy expenditure at home (Met-hours per week). To estimate the difference between pre- (Health Check 2) and post-operative (Health Check 3) physical activity, each physical activity measure for total hip and knee arthroplasty cohorts was compared from Health Check 2 to Health Check 3 using an adjusted logistic regression analysis to account for the difference in follow-up interval from operation to Health Check 3 within each cohort. A Student T-Test was performed to assess for possible differences in duration of physical activity between the arthroplasty and non-arthroplasty cohorts.

A sample size calculation was performed. Based on a 90% power to detect a standardised difference of 0.2 in EPAQ2 physical activity scores, we required 400 participants who had undergone joint replacement and 767 control participant.

For each analysis, p-value and 95% confidence intervals (CI) were estimated. A statistically significant finding was interpreted at $p \leq 0.05$. All statistical analyses were performed using STATA version 14.0 (Stata Corp, Texas, USA).

RESULTS

Of the 15,786 EPIC-Norfolk participants who attended Health Check 2, 242 underwent unilateral total hip arthroplasty and 158 unilateral total knee arthroplasty. The mean follow-up period between total hip arthroplasty and Health Check 3 was 43 months (SD: 23.2 months) and 41 months (SD: 21.8 months) in the total knee arthroplasty cohort. The demographic characteristics of each subgroup are presented as **Table 1**. Data were gathered from 767 participants who were age- and gender-matched to the arthroplasty cohort. **Table 1** demonstrates that the total hip arthroplasty, total knee arthroplasty and matched cohorts were largely comparable for their characteristics at both Health Check 2 and Health Check 3.

Table 1 Should Be Approximately Here

Total Hip Arthroplasty Cohort

At a mean follow-up of 43 months, people following total hip arthroplasty significantly reduced the number of flights of stairs climbed per week (MD: 7; $p<0.01$) and the duration of total recreational activities engaged in (MD: 1.1 hours/week; $p \leq 0.02$); this was evident for the adjusted and unadjusted analyses (**Table 2**). There was a statistically significant reduction in physical activity energy expenditure at home following total hip arthroplasty (MD: 0.1; $p<0.01$). This was only evident for the adjusted analysis. There was a statistically significant

decrease in duration of walking to work or for pleasure following total hip arthroplasty (MD: 1.4 hours/week; $p<0.01$). This was only for the unadjusted analysis (**Table 2**).

Table 2 Should Be Approximately Here

Total Knee Arthroplasty Cohort

At a mean follow-up of 41 months, people following total knee arthroplasty significantly reduced the number of flights of stairs climbed per week (MD: 10; $p<0.01$) and physical activity energy expenditure at home (MD: 6.0; $p\leq0.02$) as demonstrated in the adjusted and unadjusted analyses (**Table 2**). There was a significant reduction in the duration of walking to work or for pleasure following total knee arthroplasty (MD: 2.2 hours/week; $p<0.01$) but only for the unadjusted analysis. There was a reduction in the duration of total recreational activities (MD: 0.8 hours/week; $p<0.01$) for the adjusted analysis (**Table 2**).

Table 3 Should Be Approximately Here

Arthroplasty versus Non-Arthroplasty

The results of the analyses on duration of physical activity for those participants who underwent a total hip and knee arthroplasty compared to the non-arthroplasty matched cohort at Health Check 2 and Health Check 3 are presented in **Table 3**. There was no statistical difference in the duration of physical activity performed between people who subsequently underwent total hip or knee arthroplasty and those who did not at Health Check 2 (**Table 3**).

Following total hip arthroplasty, there was no statistically significant difference between the total hip arthroplasty and non-arthroplasty cohorts for any measure of physical activity (**Table 3**). The only exception was for the assessment of duration of total recreational activities, which was lower in the total hip arthroplasty cohort (MD: 1.8 hours/week; p=0.01).

Following total knee arthroplasty, there was lower duration of physical activity performed in the total knee arthroplasty cohort compared to the non-arthroplasty cohort at the Health Check 3 assessment (**Tables 3**). The total knee arthroplasty cohort climbed a significantly lower number of flights of stairs per week (MD: 12.0 p<0.01), duration of total recreational activities engaged in (MD: 1.7 hours/week; p=0.04) and physical activity energy expenditure at home (MD: 5.7 Met-hours/week; p=0.05) compared to the non-arthroplasty cohort. There was no statistically significant difference between the total knee arthroplasty and non-arthroplasty cohort for duration of walking to work or for pleasure (p=0.97).

DISCUSSION

The findings of this analysis of the EPIC-Norfolk cohort suggest that duration of physical activity does not increase following total hip or knee arthroplasty. The duration of physical activity may decrease following arthroplasty for some domains, most notably stair climbing and physical activity energy expenditure. This is contrary to previous understanding and belief. [7,32] There appears little difference in the physical activity levels of people 43 months following total hip arthroplasty compared to an age- and gender-matched non-arthroplasty cohort. Undergoing total hip arthroplasty therefore maintains physical activity levels at an equivalent level as the general population over time. However, following total knee arthroplasty people had lower levels of stair climbing, total recreational activity and

physical activity energy expenditure at 41 months following arthroplasty compared to an age- and gender-matched non-arthroplasty cohort.

The results from this population-based cohort provide an important addition to the evidence in this area. Although previous quantitative and qualitative data have suggested that physical activity does not increase following arthroplasty, it has been unclear whether this is dependent on activity type. This study's results suggest change in duration of physical activity may depend on the type of physical activity pursuits undertaken with various activities reporting differing magnitudes of differences over time. This difference may be explained by previous qualitative research findings. Perry et al [33] reported that following total hip and knee arthroplasty, some people are inappropriately fearful of damaging their joint replacement and reduced participation in exercise and strenuous physical activity pursuits to avoid 'wearing out' the joint. Whilst engaging in lower intensity pursuits, they avoided more physically-demanding activities. [33] As previously reported, this may be negated through greater education and increased awareness of the arthroplasty's resilience and capabilities. [32]

It has been previously thought that physical activity increases following arthroplasty through reduced pain and improved joint function. [32] Given this study's findings, physiotherapists and occupational therapists in particular should be more aware of the weakness in this previously held view. Greater education in primary and secondary care at pre- and post-operative stages should be provided to patients on their potential change in physical activity following arthroplasty. Smith et al [32] concluded that education to enlighten patients on graded physical activity should not be a 'trial and error' progression, but an informed and tailored increase, targeting patient-orientated goals. This requires both a clinician and patient shift in attitudes towards physical activity following total hip and knee arthroplasty, during

the rehabilitation phase and afterwards. This is warranted given the well-documented benefits of physical activity on improving physical and mental health, and subsequent effect that this can have on reducing the burden on health care services through improved management and reduction of non-communicable diseases such as type two diabetes, asthma, chronic obstructive pulmonary disease and coronary heart disease. [34]

Smith et al's [32] meta-ethnography reported that patients perceived that their home-based activities of daily living increased following arthroplasty. The EPIC-Norfolk dataset suggests that whilst participants may 'feel' that they are able to increase their domestic capabilities based on these previous qualitative findings, [32] this may not necessarily be represented with a quantifiable increase in activity. It is uncertain whether this can be attributed to recall bias or people misrepresenting their activities through the self-reported questionnaire used in the EPIC health checks. Further comparative studies using accelerometery and global positioning systems to measure movement and activity in sufficiently large cohorts, would be a valuable addition to the evidence-base to compare these findings.

The results indicated a difference in physical activity post-operatively for those who underwent total knee versus hip arthroplasty compared to those who did not undergo joint replacement. Whilst physical activity was maintained post-total hip arthroplasty compared to the non-arthroplasty cohort, people reported lower levels of physical activity following total knee arthroplasty compared to people of the same age and gender who did not undergo surgery. This may be related to continuing post-operative symptoms where people have reported poorer outcomes and more frequent persistent pain and functional impairment following total knee arthroplasty compared to those who undergo total hip arthroplasty. [35] Further research exploring the relationship between chronic pain, functional impairment and perceived outcomes would be useful to begin to explain this potential difference.

This study presented with four principal limitations. First, the principal objective of this study was to assess the change in duration of physical activity for people before and after total hip or knee arthroplasty. Due to the data collected within the EPIC-Norfolk cohort, it was only possible to analyse data from two specific time-points. Consequentially the intervals between surgery and physical activity measurement varied. To account for this, we undertook adjusted analyses to ensure that this variable did not influence the result. Whilst this provides insight into longer-term physical activity, it was not possible to examine whether our findings reflect shorter-term, more immediate physical activity performance within the first 12 months post-operatively.

A second limitation was that we did not adjust the analyses for the time interval between Health Check 2 to surgery. As a consequence, mobility may have reduced and then improved considerably post-operatively. Future cohorts should be assessed with shorter, more regular intervals before and after surgery to explore the importance of time on physical activity. This is particularly important given the surprising finding that a small number of people presented with osteoarthritis in the total hip and knee arthroplasty cohorts at Health Check 2 (**Table 1**). This suggests a rapid development of symptoms in the intervening period between Health Check 2 and surgery to warrant a joint replacement. Consequently, there may have been a sudden change in mobility and physical activity participation between Health Check 2 and surgery which would not have been apparent through the data collection process.

A third limitation was that the analyses were not adjusted for comorbid diseases. This was justified since, as **Table 1** demonstrates, the frequency of comorbid disease presented in the joint replacement and matched-cohorts was both low and equally matched, negating the need to adjust by this variable. Finally, physical activity was assessed using a self-reported questionnaire (EPAQ2). Whilst this has been previously validated using energy expenditure

from heart-rate monitoring with individual calibration, [29] the potential for social desirability bias and recall bias may have impacted on findings.

To conclude, the duration of physical activity does not increase following total hip or knee arthroplasty and may significantly decrease for some measures post-operatively compared to people of the same age who had not undergone a procedure. The duration of physical activity undertaken in both domestic and recreational pursuits decreases following arthroplasty. Greater awareness of this finding is required across rehabilitation professionals and the total hip and knee arthroplasty patient communities, at both pre- and post-operative consultations.

DECLARATIONS

Conflicts of Interest: The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding: This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Ethical Approval: Ethical approval for the EPIC-Norfolk cohort was granted by the National Health Service (NHS) Norfolk Research Ethics Committee.

Data Access: All data which formed the basis of these analyses are available through the EPIC-Norfolk dataset or through the authors.

CLINICAL MESSAGES

- The duration of physical activity does not increase following total hip or knee arthroplasty during the first three post-operative years.
- Total hip replacement maintains the same duration of physical activity performed as that of the general population during the first three post-operative years.
- For the majority of measures, physical activity is lower after total knee arthroplasty compared to people who have not undergone joint replacement who are of a similar age.

REFERENCES

1. Gillam MH, Lie SA, Salter A, Furnes O, Graves SE, Havelin LI, et al. The progression of end-stage osteoarthritis: analysis of data from the Australian and Norwegian joint replacement registries using a multi-state model. *Osteoarthritis and Cartilage.* 2013; 21:405-12.
2. National Joint Registry. Stats Online. Accessed on 01.12.2014. Available at: http://www.njrcentre.org.uk/njrcentre/Healthcareproviders/Accessingthedata/StatsOnline/tabid/117/Default.aspx
3. Kurtz S, Ong K, Lau E, Mowat F and Halpern M. Projections of primary and revision hip and knee arthroplasty in the United States from 2005 to 2030. *Journal of Bone and Joint Surgery (American).* 2007; 89:780-5.
4. Kohl HW, Craig CL, Lambert EV, Inoue S, Alkandari JR, Leetongin G, et al. **The pandemic of physical inactivity: global action for public health**. *Lancet* 2012; **380**:294-305.
5. Lee IM, Shiroma EJ, Lobelo F, Puska P, Blair SN, Katzmarzyk PT, et al. **Effect of physical inactivity on major non-communicable diseases worldwide: an analysis of burden of disease and life expectancy**. *Lancet* 2012; **380**:219-29.
6. Knai C, Petticrew M, Scott C, Durand MA, Eastmure E, James L, Mehrotra A, Mays N. Getting England to be more physically active: are the Public Health Responsibility Deal's physical activity pledges the answer? *International Journal of Behaviour, Nutrition and Physical Activity*. 2015;12:107.

7. Wither TM, Lister S, Sackley C, Clark A, Smith TO. Is there a difference in total physical activity levels before and after unilateral total hip arthroplasty? A systematic review and meta-analysis. *Clinical Rehabilitation*. In Press.
8. Arborelius MMCAS, Nilsson BE. Oxygen intake and walking speed before and after total hip replacement. *Clinical Orthopaedics and Related Research.* 1976; 121:113-5.
9. Arbuthnot JE, McNicholas MJ, Dashti H, Hadden WA. Total hip arthroplasty and the golfer: a study of participation and performance before and after surgery for osteoarthritis. *Journal of Arthroplasty*. 2007; 22:549-52.
10. de Groot IB, Stam HJ, Verhaar JA. Small increase of actual physical activity 6 months after total hip or knee arthroplasty. *Clinical Orthopaedics and Related Research.* 2008; 466:2201-8.
11. Delasotta LA, Rangavajjula AV, Porat MD, Frank ML, Orozco FR, Ong AC. What are young patients doing after hip reconstruction? *Journal of Arthroplasty*. 2012; 27:1518-25.
12. Harding P, Holland AE, Delany C, Hinman RS. Do activity levels increase after total hip and knee arthroplasty? *Clinical Orthopaedics and Related Research.* 2014; 472:1502-11.
13. Heiberg KE, Bruun-Olsen V, Mengshoet Am. Recovery and prediction of physical functioning outcomes during the first year after total hip arthroplasty. *Archives of Physical Medicine and Rehabilitation.* 2013; 94:1352-9.
14. Holstege MSL, Lucas C. Preoperative quadriceps strength as a predictor for short-term functional outcome after total hip replacement. *Archives of Physical Medicine and Rehabilitation.* 2011; 92:236-41.

15. Horstmann TV-K, Brauner T, Grau S, Mndermann A. Impact of total hip arthroplasty on pain, walking ability, and cardiovascular fitness. *Journal of Orthopaedic Research*. 2012; 30:2025-30.
16. Lin BA, Thomas P, Spiezia F, Loppini M, Maffulli N. Changes in daily physical activity before and after total hip arthroplasty. A pilot study using accelerometry. *Surgeon.* 2013; 11:87-91.
17. Macnicol MF, McHardy R, Chalmers J. Exercise testing before and after hip arthroplasty. *Journal of Bone and Joint Surgery (British).* 1980; 62:326-31.
18. Oosting EJ, Dronkers JJ, Naber RH, Dronkers-Landman CM Preoperative home-based physical therapy versus usual care to improve functional health of frail older adults scheduled for elective total hip arthroplasty: A pilot randomized controlled trial *Archives of Physical Medicine and Rehabilitation.* 2012; 93:610-16.
19. Pugh LG. The oxygen intake and energy cost of walking before and after unilateral hip replacement, with some observations on the use of crutches. *Journal of Bone and Joint Surgery (British).* 1973; 55:742-5.
20. Ries MD, Philbin EF, Groff GD, Sheesley KA, Richman JA, Lynch Jr F. Effect of total hip arthroplasty on cardiovascular fitness. *Journal of Arthroplasty*. 1997; 12:84-90.
21. Vissers M, Bussmann J, De Groot I, Verhaar J, Reijman M. Walking and chair rising performed in the daily life situation before and after total hip arthroplasty. *Osteoarthritis and Cartilage.* 2011; 19:1102-7.
22. Smith TO. Does physical activity change following hip and knee replacement? An analysis of data from the osteoarthritis iniative. *Bone and Joint Journal.* 2016; 98-B(Suppl):11-16.

23. Smith TO, Yates M, Macgregor A, Luben R, Sackley C, Jones A. Duration of physical activity following total hip or knee replacement: An analysis of the epic-Norfolk cohort. *Rheumatology.* 2016; 55:i134-i135.

24. Chatterji U, Ashworth MJ, Dashti H, Hadden WA. Effect of total hip arthroplasty on recreational and sporting activity. *ANZ Journal of Surgery.* 2004; 74:446-449.

25. Kahn TL, Schwarzkopf R. Does total knee arthroplasty affect physical activity levels? Data from the Osteoarthritis Initiative. *Journal of Arthroplasty*. 2015; 30:1521-5.

26. Day N, Oakes S, Luben R, Khaw KT, Bingham S, Welch A, Wareham N. EPIC-Norfolk: study design and characteristics of the cohort. European Prospective Investigation of Cancer. *British Journal of Cancer*. 1999; 80:95-103.

27. Boonstra MC,Schwering PJ, De Waal Malefijt MC, Verdonschot N. Sit-to-stand movement as a performance-based measure for patients with total knee arthroplasty. *Physical Therapy.* 2010; 90:149-56.

28. Kennedy DM, Stratford PW, Robarts S, Gollish JD. Using outcome measure results to facilitate clinical decisions the first year after total hip arthroplasty. *Journal of Orthopaedics and Sports Physical Therapy.* 2011; 41:232-9.

29. Wareham NJ, Jakes RW, Rennie KL, Mitchell J, Hennings S, Day NE. Validity and repeatability of the EPIC-Norfolk Physical Activity Questionnaire. *International Journal of Epidemiology.* 2002; 31:168-74.

30. Scott CE, Howie CR, MacDonald D, Biant LC. Predicting dissatisfaction following total knee replacement: a prospective study of 1217 patients. *Journal of Bone and Joint Surgery (British).* 2010; 92:1253-8.

31. Drexler M, Dwyer T, Chakravertty R, Farno A, Backstein D. Assuring the happy total knee replacement patient. *Bone and Joint Journal.* 2013; 95 (11 SupplA):120-23.

32. Smith TO, Latham SK, Maskrey V, Blyth A. What are people's perceptions of physical activity before and after joint replacement? A systematic review and meta-ethnography. *Postgraduate Medical Journal.* 2015; 91:483-491.
33. Perry MA, Hudson S, Ardis K. "If I didn't have anybody, what would I have done?": Experiences of older adults and their discharge home after lower limb orthopaedic surgery. *Journal of Rehabilitation Medicine*. 2011; 43:916-22.
34. Sallis R. Exercise is medicine: a call to action for physicians to assess and prescribe exercise. *Physician and Sportsmedicine.* 2015; 43:22-6.
35. Choi JK, Geller JA, Yoon RS, Wang W, Macaulay W. Comparison of total hip and knee arthroplasty cohorts and short-term outcomes from a single-center joint registry. *Journal of Arthroplasty*. 2012; 27: 837-41.

TABLE LEGENDS

Table 1: Demographic characteristics

Table 2: Analysis results comparing physical activity change between Health Check 2 and Health Check 3 for the total hip arthroplasty, total knee arthroplasty and the matched cohort.

Table 3: Analysis results comparing the difference in physical activity change between people who undergo total hip or knee arthroplasty and the matched cohort.

Table 1: Demographic characteristics

	Total Hip Arthroplasty	**Total Knee Arthroplasty**	**Matched Control**
N	242	158	767
Mean age at Health Check 2 (years; SD)	66.0 (7.0)	67.1 (7.0)	66.4 (7.1)
Mean age at Arthroplasty (years; SD)	70.4 (6.8)	71.7 (6.7)	N/A
Mean age at Health Check 3 (SD)	74.0 (6.9)	75.0 (6.9)	73.9 (6.9)
Gender (m/f; %)	96/146	67/91	315/452
Mean BMI at Health Check 2 (kgs/m^2; SD)	28.4 (4.6)	30.1 (4.7)	26.9 (3.8)
Mean BMI at Health Check 3 (kgs/m^2; SD)	28.8 (4.6)	31.6 (5.1)	26.4 (3.5)
Previous MI at Health Check 2 (Y; %)	8 (3.3)	3 (1.9)	28 (3.7)
Prevalent MI at Health Check 3 (Y;%)	10 (4.1)	4 (2.5)	23 (3.0)
Previous stroke at Health Check 2 (Y; %)	4 (1.7)	5 (3.2)	31 (4.0)
Prevalent stroke at Health Check 3 (Y;%)	5 (2.1)	5 (3.2)	12 (1.6)
Diagnosis of diabetes at Health Check 2 (Y;%)	7 (2.9)	7 (4.4)	33 (4.3)
Prevalent diabetes at Health Check 3 (Y;%)	10 (4.1)	8 (5.1)	16 (2.1)
Diagnosis of asthma at Health Check 2 (Y; %)	27 (11.2)	17 (10.8)	84 (11.0)
Diagnosis of arthritis at Health Check 2 (Y;%)	165 (68.20)	123 (77.8)	258 (33.6)
Mean duration from Health Check 2 to Arthroplasty (months; SD)	48.2 (23.3)	50.8 (22.0)	N/A
Mean duration from Arthroplasty to Health Check 3 (months; SD)	43.2 (23.2)	40.5 (21.8)	N/A

BMI – body mass index; f – female; kgs- kilograms; kgs/m^2 – kilograms per meter squared; m – male; MI – myocardial infarct; N – number; N/A – not applicable; SD- standard deviation; Y - Yes

Table 2: Analysis results comparing physical activity change between Health Check 2 and Health Check 3 for the total hip arthroplasty, total knee arthroplasty and the matched cohort.

	Health Check 2	Health Check 3	Difference Health Check 2 to Health Check 3		
	(Mean; SD)	(Mean; SD)	(Mean Difference; SD)	Unadjusted (P-value 95% CI)	Adjusted Regression (P-value; 95% CI)
Total Hip Arthroplasty (n=242)					
Number of flight of stairs climbed per week	34.95 (36.37)	28.12 (34.71)	-6.83 (29.41)	<0.01 (3.10, 10.57)	<0.001 (0.59, 0.83)
Duration of walking to work/for pleasure (hrs/week)	1.76 (2.82)	0.39 (1.22)	-1.37 (2.34)	<0.01 (0.52, 2.21)	0.48 (-6.81, 11.39)
Duration of total recreational activity (hrs/week)	8.22 (6.81)	7.14 (7.15)	-1.08 (7.08)	0.02 (0.16, 1.99)	<0.001 (0.38, 0.66)
PAEE at home (Met-hrs/week)	46.48 (29.75)	46.60 (32.88)	0.12 (32.24)	0.96 (-4.21, 3.97)	<0.001 (0.33, 0.57)
Total Knee Arthroplasty (n=158)					
Number of flight of stairs climbed per week	29.91 (37.96)	19.70 (30.35)	-10.22 (31.99)	<0.01 (5.19, 15.24)	<0.001 (0.34, 0.61)
Duration of walking to work/for pleasure (hrs/week)	2.62 (2.68)	0.45 (1.37)	-2.17 (2.51)	<0.01 (1.09, 3.26)	0.193 (-0.37, 1.20)
Duration of total recreational activity (hrs/week)	8.06 (7.59)	7.26 (9.00)	-0.80 (9.29)	0.29 (-0.70, 2.29)	0.004 (0.14, 0.71)
PAEE at home (Met-hrs/week)	48.17 (34.67)	42.13 (31.81)	-6.04 (32.35)	0.02 (0.96, 11.13)	<0.001 (0.28, 0.61)
Matched Cohort (n=767)					
Number of flight of stairs climbed per week	34.70 (37.83)	31.72 (38.33)	-2.98 (29.18)	0.01 (0.59, 5.37)	N/E
Duration of walking to work/for pleasure (hrs/week)	2.46 (2.55)	0.46 (1.13)	-1.99 (2.45)	<0.01 (1.50, 2.48)	N/E
Duration of total recreational activity (hrs/week)	9.67 (8.72)	8.95 (9.06)	-0.73 (9.61)	0.07 (-0.07, 1.52)	N/E
PAEE at home (Met-hrs/week)	47.72 (31.61)	47.83 (31.72)	0.10 (29.49)	0.93 (- 2.52, 2.31)	N/E

* denotes p≤0.05; CI – confidence intervals; hrs/day – hours per day; hrs/week – hours per week; N/E – not estimated as no arthroplasty procedure; PAEE – physical activity energy expenditure; P=Value – probability value; SD – standard deviation; THA – total hip arthroplasty; Y – yes

Table 3: Analysis results comparing the difference in physical activity change between people who undergo total hip or knee arthroplasty and the matched cohort.

Physical activity measure	Health Check 2		Health Check 3	
	Mean Difference (95% CI)	P-value	Mean Difference (95% CI)	P-value
Total Hip Arthroplasty versus Non-Arthroplasty				
Number of flight of stairs climbed per week	1.25 (-4.20, 6.70)	0.65	-3.60 (-9.23, 2.02)	0.21
Duration of walking to work/for pleasure (hrs/week)	0.11 (-0.59, 0.81)	0.75	-0.08 (-0.49, 0.32)	0.69
Duration of total recreational activity (hrs/week)	-1.02 (-2.19, 0.15)	0.09	-1.80 (-3.11, -0.50)	0.01
PAEE at home (Met-hrs/week)	-0.05 (-4.47, 4.37)	0.98	-1.23 (-6.06, 3.60)	0.62
Total Knee Arthroplasty versus Non-Arthroplasty				
Number of flight of stairs climbed per week	3.64 (-2.88,10.17)	0.27	12.02 (5.53, 18.50)	<0.001
Duration of walking to work/for pleasure (hrs/week)	-0.45 (-1.40, 0.51)	0.36	0.01 (-0.46, 0.48)	0.97
Duration of total recreational activity (hrs/week)	1.37 (-0.04, 2.78)	0.06	1.67 (0.05, 3.30)	0.04
PAEE at home (Met-hrs/week)	-1.52 (-6.92, 3.88)	0.58	5.70 (0.10, 11.29)	0.05

CI – confidence intervals; hrs/day – hours per day; hrs/week – hours per week; PAEE – physical activity energy expenditure; Y - yes